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ABSTRACT

Rather than abandon reading expectancy formulae because they produce different reading expectancy scores, educators should attempt to improve such formulae in order to make appropriate decisions about students. Potential reading levels derived from the use of various expectancy formulae may be compared after converting the scores to stanines, which are more stable. Using a conversion method, seven reading expectancy formulae were tested with 161 elementary school students: 40 second graders, 48 fourth graders, and 73 sixth graders. A t-test was used to determine if the mean IQ scores of the sample were significantly different from the "normal" mean IQ of 100. The scores of both the second and fourth grade sample were significantly different, although the sixth grade scores were not. When classifying students as able or disabled readers, the Horn formula, the adapted Harris formula, and the Monroe formula were in agreement at least 90% of the time. At 70% agreement, the Gilliland and Carner formulae would also be acceptable. This study, previous studies, and clinical observation suggest the advisability of using the adapted Harris formula. (Tables and figures illustrate the text.) (JF)

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COMPARING READING EXPECTANCY FORMULAE AFTER CONVERTING THE EXPECTANCY SCORES TO EXPECTANCY STANINES

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One technique that is being used to screen students for diagnosis is to compare a student's estimated potential, usually obtained from an intelligence test, with his observed reading score from a standardized test. If the estimated potential is significantly greater than the observed reading score, the student is referred for further diagnosis. Once an estimated IQ or mental age is obtained, an estimated potential can be determined by using one of the various reading expectancy formulae. However, these various reading expectancy formulae produce different reading expectancy scores, which, when compared to an observed reading performance score can lead to different decisions about a student. That is, by using one reading expectancy formula and comparing that score to an observed reading score, a child may appear to need further diagnosis, while using another reading expectancy formula and comparing that score to the same observed reading score, the child may appear not to need referral for further diagnosis.

Since the scores from different IQ tests vary, scores from the different reading expectancy formulae vary, and observed reading scores vary from one standardized test to another, some reading specialists suggest that using a discrepancy criteria between a child's estimated potential and the observed reading performance is not useful for screening

C SD84 269

students for diagnosis.

Rather than abandoning the concept, why not attempt to improve the tests and expectancy formulae in order to make appropriate decisions about students? It is not being suggested that this should be the only criterion for screening students; however, comparing a student's estimated potential to be an observed performance certainly should be one technique for screening. It is at least as good as any other technique that is available at this time. Certainly, other variables such as teacher observation, student's experiential background, and student's motivation should also be taken into consideration.

The major purpose of this paper is to compare potential reading levels derived from the use of various expectancy formulae after converting the scores to stanines.

Converting Reading Expectancy Scores to Stanines

The comparison between estimated potential and observed reading level to identify students as candidates for diagnosis is usually made using grade equivalent scores. That is, the expected reading potential and the observed reading scores are both converted to grade equivalents and then compared. While the definition of reading disability varies from author to author, a significant discrepancy for the following grades is usually:

Grades 1 and 2 - if the estimated potential is at least a half year greater than the observed performance, the student should be referred for diagnosis.

Grades 3 and 4 - the discrepancy should be at least three-fourths of a year.

Grades 5 and above - the discrepancy should be at least 1 year.

There are several problems with using the grade equivalents and comparing scores. First, no account of standard error is really considered. A discrepancy of .5 a year or .75 a year may very likely not be significant if the standard error of both IQ and reading tests are taken into account. Second, the distance between scores is not equidistant when using grade equivalents. That is, the distance between 3.0 and 4.0 is not necessarily the same as between 4.0 and 5.0. Grade equivalents do not represent equal units. Third, grade equivalent scores are unstable, in that they are not as gross a score as some other types such as stanines. Fourth, grade equivalents are not directly comparable from one test to another. Stanines, on the other hand, are approximately equal units, comparable across tests, and stable.

The original process of converting the various reading expectancy formulae to stanines was suggested to the author by Professor William R. Powell who teaches at the University of Florida. The process described by Professor Powell has been slightly adapted by the author in order to use the process with the Metropolitan Achievement Test (1971).

The following is the conversion process:

1. Obtain an estimated reading potential score in grade equivalents using a reading expectancy formula. (If the expectancy score is an age score, subtract 5.2 to determine a grade score. [Harris & Sipay, 1975].)

2. Go to the tables for converting raw scores to the various

standard scores of the test manual that was used to obtain an observed reading score. In this study, the Metropolitan Achievement Test (MAT) was used. Using the MAT table for converting standard scores to grade equivalents, simply convert the expected grade equivalent to an expected standard score.

3. Then moving to the tables where one can convert the standard scores to percentiles or stanines, convert the expected standard score to an expected stanine.* This expected stanine is now based on the same normed group as the observed reading score and is theoretically the score the student should obtain if he is working up to his potential.

4. Convert the observed raw score to an observed standard score.

5. Convert the observed standard score to an observed stanine.

6. If the expected stanine exceeds the observed stanine by two or more stanines, the child should be referred for further diagnosis.

There appears to be several advantages to using this technique when screening students. First, the discrepancy factor for defining reading disability remains constant across grade levels. That is, the criterion for defining disability is that the expected reading stanine exceeds the observed reading stanine by at least two stanines. Second, the stanines for both potential and performance are based on the same normed group. With that in mind, the discrepancy between potential and performance for defining disability should be significant. Third, the scores are more stable and reduces the error between the two measures.

When expectancy scores are converted to stanines, the scores become

*In most other manuals the conversion process is converting the expected grade equivalent to an expected raw score, and then converting the expected raw score to an expected stanine.

more stable and there should not be the significant discrepancy among the reading expectancy formulae that exist when grade equivalents are used. That is, the conversion of the reading expectancy scores to stanines should stabilize the scores to the point where similar decisions of whether a child is referred for diagnosis or not should be about the same, no matter which reading expectancy formula is used. To test this, the following hypothesis was developed: Using seven reading expectancy formulae and converting the scores to stanines (as described above) and comparing the expectancy stanines to an observed reading stanine the agreement of classification of able and disabled readers will be at least 90% for the combinations of reading expectancy formulae.

Reading Expectancy Formulae Used in This Study

There are many formulae and calculating devices for estimating reading expectancy. Seven of these formulae have been selected for this study. In some cases, adaptations had to be made to an original formula in order to make it comparable to the other formulae. It is important for the reader to keep this in mind, because the decision made by these adaptations is not necessarily the same decision that would have been derived had the original formula been used. For example, Monroe (1932) used an index score which was determined by dividing the reading grade by chronological grade plus mental grade, plus arithmetic grade divided by three (Reading Expectancy Grade/REG/ =

$$\frac{\text{Chronological grade + mental grade + arithmetic grade}}{3};$$

$$\text{Reading Index} = \frac{\text{Reading Grade}}{\text{Reading Expectancy Grade}}.$$

If the student had a reading index below .80, he was considered a disabled reader and should be given

a more extensive diagnosis. For this particular study, it was necessary to convert Monroe's Reading Expectancy Grade to a stanine and then compare that score to an observed reading stanine.

Probably the most often used reading expectancy formula is the one developed by Bond (1973). Embedded in this formula are the assumptions that consideration should be given for the child's opportunity to learn as well as an estimated potential to learn. The formula appears to predict adequately for students whose estimated potentials fall in the average range; however, extreme IQ scores tend to be compressed toward the mean using the Bond formula. That is to say, this formula tends to overestimate the reading potential of dull students and underestimate the reading potential of bright students.

Carner (Putnam, 1974) adapted the Bond Formula in order that the formula "fit" reading achievement better for the dull and bright students. Carner added one-tenth of a point to the constant 1.0 for every two IQ points above 110 and subtracted one-tenth of a point from the constant 1.0 for every two IQ points below 90. For those students whose estimated IQ scores fell between 90 and 110, Carner used the Bond formula.

Gilliland's (1974) formula also appears to be a modification of Bond's formula. "The formula is based on the assumptions that a child begins to learn reading skills when he enters first grade and that his rate of progress is dependent upon his ability." (Gilliland, 1974, p. 43) If the student's observed reading score is less than two-thirds his reading expectancy level, that student would be considered a disabled reader.

Assumptions inherent in the Horn Formulae are that mental age becomes a more effective predictor of school achievement as a child progresses through school. In the primary grades, factors such as emotional maturity, social adjustment, work habits, coordination, attention span, etc., can be accounted for by chronological age. (Torgerson & Adams, 1956)

Harris and Sipay (1975) and Lewerenz (1939) recommend determining reading expectancy age using the same formula. That is, multiply two times the mental age plus chronological age divided by three. Lewerenz (1939) stated that a pupil's achievement in any subject usually falls between his mental age and his chronological age.

Harris and Sipay (1975) recommend giving consideration to general maturing as well as mental age. This is done by giving chronological age some weight in the expectancy formula they recommend. It should be noted that Harris' formula for defining reading disability has been altered in this study. Harris uses an index to determine if a child is reading disabled. It was not possible to use his index in this study.

The Monroe formula uses equal weights of mental grade, chronological grade, and arithmetic grade. Monroe's (1932) data of discrepancies between arithmetic and reading suggested that for her control group the average discrepancy was about one-third grade's acceleration in reading above arithmetic. For reading defect cases, the arithmetic scores and the average were approximately one and one-fourth to one and three-fourths grades above reading scores.

The seventh formula used was the mental grade formula. The implicit assumption made using this formula as a predictor of reading achievement is that there is almost a perfect correlation between mental grade and

reading grade. Figure 1 shows the formulae used in this study.

Place Figure 1 Here

Sample

The sample was all second, fourth, and sixth grade students that completed the Cognitive Abilities Non-verbal Section and the Metropolitan Achievement Test, Reading, in a rural elementary school in North Central Florida. The total sample was 161 students; 40 second grade students, 48 fourth grade students, and 73 sixth grade students. See Figure 2 for the breakdown of sex and race for each grade level.

Place Figure 2 Here

The mean, standard deviation, and range for each grade level can be seen in Table 1.

Place Table 1 Here

A t- test was used to determine if the mean score of the sample was significantly different from the mean score of a "normal" population with a mean IQ of 100. Both second and fourth grade samples used in this study have mean IQ scores significantly different from a "normal" population at the .01 level of significance. The sixth grade sample was not significantly different from a "normal" population at the .01 level of significance.

Results

This study tested the hypothesis that when seven reading expectancy formulae are converted to stanines using the process described in this paper, there will be at least 90% agreement in identifying able and disabled readers among the various combinations of reading expectancy formulae. That is, if using one reading expectancy formula and comparing it to the students' observed reading achievement score classifies the student as an able or disabled reader, then using another reading expectancy formula and comparing it to that same observed reading score should classify the student the same as the previous formula at least 90 percent of the time.

To test the hypothesis, two by two contingency tables were set up (see Figure 3). The data were analyzed using a z value derived from a test of proportions. A one-tailed test at the .01 level of significance was used to determine whether each hypothesis was accepted or not accepted. For each hypothesis, one needed to find the proportion of the sample that was identified by two reading expectancy formulae as able - able (box A in Figure 3) and disabled - disabled (box - D in Figure 3). The arbitrarily selected 90 percent ("a" in the formula) was subtracted from the observed proportion ("p" in the formula), and the difference was divided by the standard deviation of .90 ($\sqrt{a(1-a)/n}$). From this, a z value was determined. (Glass and Stanley, 1970). For example, for the second grade sample (N=48), the proportion of subjects that were classified the same by both the Mental Grade formula and the adapted Harris formula was

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Place Figure 4 Here

47/48 or .979. Using the formula, $z = \frac{p-a}{\sqrt{a(1-a)/n}} = \frac{.979 - .90}{\sqrt{.90(.10)/48}} =$ 1.84. Since the critical value of z at the .01 level of significance is -2.32, the hypothesis was accepted.

Rather than discuss 63 hypotheses separately that are summarized in Table 2, a discussion will be presented to analyze the data. It can be observed from Table 2 that the hypotheses comparing the adapted Harris and the Horn formulae are accepted for all grade levels examined. This is also true for the Mental Grade formula and the Gilliland formula, the Bond and Carner formulae, the adapted Harris and the Monroe formulae, the Gilliland and the Monroe formulae, and the Horn and the Monroe formulae.

Closer observation would indicate that when classifying students as able or disabled readers, the Horn formula, the adapted Harris formula, and the Monroe formula are in agreement at least 90 percent of the time for grades 2, 4, and 6. If one is willing to accept less than 90 percent agreement, and accept 70 percent agreement, then the Gilliland and the Carner formulae would also be acceptable. The formula that produce the greatest differences differences in classifying students are the Bond and the Mental Grade formulae. Even when a standard score that is as gross as stanines is used, the weaknesses of the Mental Grade formula and the Bond formula appear to still exist. That is, using the Mental Grade formula, expectancy scores for the dull students are too low, and for the bright child, too high. The Gilliland formula tends to produce scores that are similar to the Mental Grade formula. The Bond formula appears to produce expectancy scores that are unrealistically high for the dull students and too low for the bright students.

Which formulae should or could be used to realistically predict reading ability? Probably formulae that predict reading expectancies between the Bond formula and the Mental Grade formula since it has been shown many times that these formulae are inadequate at the extremes. Studies by Simmons and Shapiro (1968), Briuninks, Glaman, and Clark (1973), and Rodenborn (1974) have consistently shown the Horn formula scores to fall between the Mental Grade and Bond Formulae scores particularly at the dull and bright levels. The Horn formula is probably more realistic to use than Mental Grade or Bond. However, the Monroe and adapted Harris formulae classified students basically as the Horn formula and either one of them is also appropriate. Because a goal in screening students is to minimize testing and teacher work, it is my recommendation based on this study, previous studies, and clinical observation to use the adapted Harris formula. Since the Monroe formula requires an arithmetic score (additional testing), and the Horn formulae vary with age levels, meaning remembering four formulae as opposed to one, and one can identify the same group for diagnosis using the adapted Harris formula, it may be the simplest and most useful for all concerned.

REFERENCES

Bond, Guy L. and Fay, Leo C. "A Comparison of the Performance of Good and Poor Readers on the Individual Items of the Stanford-Binet Scale, Forms L and M," Journal of Educational Research, Vol. XLIII, No. 6 (February, 1950), 475-479.

Bond, Guy L. and Tinker, Miles A. Reading Difficulties: Their Diagnosis and Correction, Third Edition. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1973.

Bruininks, Robert H., Glaman, Gertrude M., and Clark, Charlotte R. "Issues in Determining Prevalence of Reading Retardation," The Reading Teacher, Vol. 27, No. 2, (November, 1973), 177-185.

Gilliland, Hap. A Practical Guide to Remedial Reading, Columbus, Ohio: Charles E. Merrill Publishing, 1974.

Glass, Gene V. and Stanley, Julian C. Statistical Methods in Education and Psychology, Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1970.

Harris, Albert J. and Sipay, Edward R. How to Increase Reading Ability, Sixth Edition, New York: David McKay Company, Inc., 1975.

Lewerenz, Alfred S. "Selection of Reading Materials by Pupil Ability and Interest," Elementary English Review, Vol. 16, No. 4, (April, 1939), 151-156.

Monroe, Marion. Children Who Cannot Read, Chicago: The University of Chicago Press, 1932.

Putnam, Lillian R. "Determination of Reading Expectancy Level?" Reading News, Vol. 3, No. 2, (April, 1974), 2-3.

Rodenborn, Leo V. "Determining, Using Expectancy Formulas," The Reading Teacher, Vol. 28, No. 3, (November, 1974), 286-291.

Smith, Lawrence L. "Comparing Reading Sets as Determined From Selected Intelligence Measures," Reading Improvement, Vol. 12, No. 4, (Winter, 1975), 212-219.

Torgerson, Theodore L. and Adams, Georgia S. Measurement and Evaluation for the Secondary School Teacher. New York: The Dryden Press, 1956.

Figure 1

Reading Expectancy Formulas used in This Study

1. Mental Age Formula
   Mental Age = Reading Expectancy Age (REA)
   Reading Age - 5.2 = Reading Expectancy Grade (REG)

2. Bond and Tinker Formula
   $(\text{years in School} \times \frac{IQ}{100}) + 1.0 = REG$

3. Carner's Formula
   For students with IQ's between 90 and 110, it is the same as the Bond and Tinker Formula.

   For those students with IQ's less than 90:
   To determine constant:
   1. 89 - IQ = a
   2. a + 2 = b
   3. b x .1 = .b
   4. 1 - .b = constant

   $(\text{years in school} \times \frac{IQ}{100}) + \text{constant} = REG$

   For students with IQ's above 110: $(\text{years in school} \times \frac{IQ}{100}) + \text{constant} =$ REG to determine constant:

   1. IQ - 111 = a
   2. a ÷ 2 = b
   3. b x .1 = .b
   4. 1 + .b = constant

4. Harris Formula
   $2\,\frac{MA + CA}{3} = REA$

5. Gilliland Formula
   $\frac{(IQ + (IQ - 100)}{100} \times \text{Grade in school} = \text{Reading Expectancy Grade}$

Expectancy

6. Horn Formula

Ages 6-0 to 8-5

$$\frac{MA + CA}{2} = REA$$

$$REA - 5.2 = REG$$

Ages 8-6 to 9-11

$$\frac{3MA + 2CA}{5} = REA$$

$$REA - 5.2 = REG$$

Ages 10-0 to 11-11

$$\frac{2MA + CA}{3} = REA$$

$$REA - 5.2 = REG$$

Ages 12-0 and above

$$\frac{3MA + CA}{4} = REA$$

$$REA - 5.2 = REG$$

7. Monroe Formula

$$\frac{CG + MG + AG}{3} = REG$$

Table 1

	$\bar{X}$	Sd	Range
Second Grade	89	11	70-110
Fourth Grade	94	14	69-132
Sixth Grade	96	1	64-127

Figure 2

	Male		Female		
	Black	White	Black	White	Total
2nd	12	13	6	17	48
4th	8	13	7	12	40
6th	16	26	9	22	73
					161

Expectanc

Figure 3

Horn Formula

Mental Grade Formula		ABLE	DISABLED
	ABLE	A	B
	DISABLED	C	D

Figure 4

Grade 2

Harris

Mental Grade		Able	Disabled	
	Able	(43)	1	44
	Disabled	0	(4)	4
		43	5	(48)

TABLE 2

	Grade 2		Grade 4		Grade 6	
	Proportion	Observed Z Value	Proportion	Z Value	Proportion	Z Value
Mental Grade vs Bond	.667	-5.42*	.650	-5.32*	.808	-2.62*
Mental Grade vs Carner	.771	-3.00*	.700	-4.26*	.918	.51
Mental Grade vs Harris	.979	1.84	.775	-2.66*	.932	.90
Mental Grade vs Gilliland	.938	.87	.900	0	.918	.51
Mental Grade vs Horn	.854	-1.07	.725	-3.72*	.932	.90
Mental Grade vs Monroe	.875	- .58	.775	-2.66*	.932	.90
Bond vs Carner	.854	-1.07	.950	1.06	.918	.51
Bond vs Harris	.646	-5.91*	.825	-1.60	.890	- .27
Bond vs Gilliland	.688	-4.94*	.700	-4.26*	.767	-3.80*
Bond vs Horn	.688	-4.94*	.800	-2.13	.890	- .27
Bond vs Monroe	.667	-5.42*	.775	-2.66*	.890	- .27
Carner vs Harris	.792	-2.52*	.825	-1.60	.904	.12
Carner vs Gilliland	.833	-1.55	.750	-3.19*	.849	-1.45
Carner vs Horn	.792	-2.52*	.800	-2.13	.945	1.29
Carner vs Monroe	.813	-2.03	.775	-2.66*	.904	.12
Harris vs Gilliland	.917	.39	.750	-3.19*	.849	-1.45
Harris vs Horn	.875	- .58	.950	1.06	1	2.86
Harris vs Monroe	.896	- .097	.950	1.06	.945	1.29
Gilliland vs Horne	.833	-1.55	.725	-3.72*	.863	-1.06
Gilliland vs Monroe	.854	-1.07	.875	- .53	.877	- .67
Horn vs Monroe	.938	.87	.950	1.06	.945	1.29

* One tailed test at .01 level - critical value -2.32